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BIOLOGICAL EVALUATION OF INSECT DAMAGE AT THE OUACHITA SEED ORCHARD, OUACHITA NATIONAL FOREST (1983)

by

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Abstract

A seed orchard scouting program consisting of 5 visits was conducted during the 1983 growing season at the Ouachita Seed Orchard, Mt. Ida, Arkansas. Approximately 723 bushels of the 1983 shortleaf cone crop and 386 bushels of the 1984 cone crop were predicted to be present in the East Ouachita seed source as of October 1983. These crop estimates represent the survival of 38% of the 1983 crop from March 1982 to October 1983 and the survival of 33% of the 1984 crop from March 1983 to October 1983. Insects were the major identifiable mortality agents causing losses to both crops. Forest Pest Management (FPM) recommends that a series of aerial pesticide applications be continued in 1984.

INTRODUCTION

A seed orchard scouting program was initiated during 1982. This scouting program was designed to:

1) quantify the losses attributed to the major agents
2) determine loss periods
3) determine the effect these losses will have on the projected cone crop
4) identify areas where modifications could be made to the current pest management strategy to better respond to pest pressures.

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A scouting crew from Forest Pest Management (FPM), Alexandria Field Office, monitored damage incidences and pest populations during the 1982 and 1983 growing seasons. During these visits data were compiled supporting the premise that insects are the major identifiable mortality agents (Overgaard et al. 1974) and, if not controlled, will adversely affect the availability of superior pine seed, thereby reducing future timber production (Barber 1982). Because a shortage in shortleaf seed from the Ouachita, Ozark, and Missouri seed sources exists, personnel from the Ouachita National Forest are interested in maximizing seed production. Based upon the results of these evaluations, Forest Pest Management recommends a series of aerial pesticide applications for suppression of key pest populations.

METHODS OF EVALUATING INSECT POPULATIONS AND LOSSES

Pest management decisions are dependent upon accurate predictions and assessments of crop production levels (I), pest population levels (II), and associated damage levels (III). Three inventory-monitoring systems were implemented to quantify this information.

I. Assessment of Crop Production Levels

A. Selection of sample trees for inventory-monitoring system (Bramlett and Godbee 1982)

Sixteen clones of the East Ouachita shortleaf seed source were utilized as inventory clones. In 1981, 10 clones were selected from the high production class, 4 clones were selected from the medium production class, and 2 clones were selected from the low production class. Four ramets were sampled from each of the inventory clones. One clone from the high production class was eliminated after the 1981 season. Table 1 lists the selected clones, the number of ramets sampled, and the number of ramets of each clone within the E. Ouachita seed source.

Samples were taken from ramets of 56% of the high producing clones, 19% of the medium producing clones, and 11% of the low producing clones.

B. Inventory procedures

The upper and lower crown of each sample tree was divided into quadrants. The average number of flowers per cluster for each of the 8 areas of the crown was obtained by counting the number of flowers in 4 clusters located within each area and dividing by 4. Prior to conelet closure, all of the candles bearing flower clusters within each area of the tree crown were estimated. This number was multiplied by the average number of flowers per cluster and entered on the data sheet as a total tree count.

Table 1. Clones and the number of ramets sampled in each production class.

Clone	Production Classes					
	High		Medium		Low	
	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)
2	4	162				
8	4	177				
11	4	144				
20	4	115				
22			4	67		
23	4	181				
28			4	148		
32					4	89
34			4	139		
38	4	139				
39					4	131
43			4	161		
46	4	150				
47	4	183				
49	4	127				
TOTAL	36	1,378	16	515	8	220

Eight branches selected in 1981 were resampled in March, April, June, August, and October 1983, and the number of female flowers and 2nd year cones found on each tagged branch was recorded. During the first visit, new branches were selected for any missing tagged branches. If a tagged branch no longer contained any flowers or cones the tag was removed.

II. Assessment of Key Pest Populations

Shortleaf pine seed orchard managers experience flower and cone losses due to several species of insect pests. The following are key insect pests causing flower, conelet, and cone damage on shortleaf pine.

Rhyacionia frustrana (Comstock)	Nantucket pine tip moth
Leptoglossus corculus (Say)	Leaffooted pine seedbug
Tetyra bipunctata (H.-S.)	Shieldbacked pine seedbug
Family Cecidomyiidae	Cone feeding midges
Dioryctria merkeli Mutuura & Munroe	Loblolly pine coneworm
Dioryctria amatella (Hulst)	Southern pine coneworm
Dioryctria clarioralis (Walker)	Blister coneworm
Eucosma cocana Kearfott	Shortleaf pine cone borer

Currently there are no techniques to predict population trends for any of these pests. A few techniques are available which can detect the presence of certain pests.

A. Pheromone trapping for Diorcytria spp.

Pheromone trapping techniques are available for 4 coneworm species, *D. disclusa*, *D. clarioralis*, *D. merkeli*, and *D. amatella*. Because pheromone trapping for these species is a relatively new technique, a standardized trapping scheme has not been developed. In the interim, Forest Service Research recommended using 10 Pherocon 1C® traps baited with each pheromone. Traps were hung with a pulley system from an upper limb located within the top 10 feet of the crown. Twice a week orchard personnel checked the traps, recording the number of male moths. Baits were changed monthly.

B. Pheromone trapping for Rhyacionia frustrana

Pheromone lures for the Nantucket pine tip moth are available commercially from Albany International. A standardized trapping scheme for shortleaf seed orchards has not been developed. However, Albany International recommended that 1 trap station should be maintained for every 2 1/2 acres. A technique has been developed by which a seed orchard manager can predict the optimum spray date using pheromone traps and daily

maximum and minimum temperatures (Gargiullo et al. 1983). Traps must be in place by the middle to the end of February. A copy of the Georgia Forest Research Paper #44 (Gargiullo et al. 1983) which explains the spray timing methods is included in Appendix II.

C. Visual searches for *Leptoglossus corculus* and *Tetyra bipunctata*

Attractive trapping methods are not available for either species of seedbug commonly found in seed orchards. Beginning in late March visual searches were made of all branches sampled during the cone and seed inventory-monitoring system. The number of seedbugs sighted was recorded.

III. Assessment of Impact Caused by Key Pests

Data were gathered, which were used to generate impact estimates, by identifying causes of mortality for cones and conelets inventoried in the cone and seed inventory-monitoring system.

RESULTS AND DISCUSSION

I. Assessment of Crop Production Levels

Based upon the cone and seed inventory-monitoring system, approximately 723 bushels of cones were predicted to be present in the E. Ouachita seed source at harvest (1983). This estimate represents the survival of 38% of the original estimate made in March 1982. In addition, 386 bushels of cones (predicted 1984 crop) are currently on the trees. This estimate represents the survival of 33% of the original estimate made in March 1983. Predictions based on a generalized survival curve indicate that approximately 150 bushels of East Ouachita shortleaf cones should be harvested in October 1984. Tables 2 and 3 summarize these predictions for the 1983 and 1984 crops, respectively.

The following assumptions were used in predicting the size of the 1983 and 1984 cone crop.

1. Sample ramets are representative of all of the ramets of the selected clones.

2. Selected clones represent production levels of unsampled clones.

3. One bushel contains 1600 cones.

4. One pound of seed can be extracted from a bushel of cones.

Table 2. Estimation, based on the inventory-monitoring system, of 1983 E. Ouachita shortleaf cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
March 1982			
Potential	3,018,817	1,887	1,887
Predicted	1,811,290	1,132	1,132
May 1982			
Potential	1,871,667	1,170	1,170
Predicted	815,081	509	509
June 1982			
Potential	1,660,349	1,038	1,038
Predicted	754,704	472	472
August 1982			
Potential	1,539,597	962	962
Predicted	784,892	491	491
October 1982			
Potential	1,328,279	830	830
Predicted	724,516	453	453
April 1983			
Potential	1,298,091	811	811
Predicted	845,269	528	528
June 1983			
Potential	1,184,836	741	741
Predicted	851,081	509	509
July 1983			
Potential	1,169,985	731	731
Predicted	875,457	547	547
October 1983			
Potential	1,156,407	723	723
Predicted	1,156,407	723	723

Table 3. Estimation, based on the inventory-monitoring system, of 1984 E. Ouachita shortleaf cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
March 1983			
Potential	1,849,460	1,156	1,156
Predicted	1,109,676	694	694
April 1983			
Potential	1,849,460	1,156	1,156
Predicted	1,202,149	751	751
June 1983			
Potential	621,040	388	388
Predicted	73,978	46	46
July 1983			
Potential	639,436	400	400
Predicted	184,946	116	116
October 1983			
Potential	617,007	386	386
Predicted	240,430	150	150

5. Potential estimates are based on the survival of 100% of the flowers or cones from each visit until harvest.

6. Predicted estimates are based on a generalized survival curve which predicts the crop size expected at maturity when additional mortality occurs.

The orchard production in bushels of cones for the 1983 and 1984 cone crops are illustrated in figures 1A & 1B. The dashed lines on each graph represent the generalized curves compiled by Bramlett and Godbee (1982) for cone survival in a moderately managed loblolly orchard. As data become available for shortleaf cone survival, a generalized curve will be developed which will more accurately describe survival in shortleaf seed sources. The solid lines represent the actual cone survival based upon periodic observations of tagged branches.

II. Assessment of Key Pest Populations and Impact

A. Tip moths

Species - *Rhyacionia frustrana* (Comstock) - Nantucket pine tip moth

Biology - Tip moths are usually considered pests of young pine plantations. However, the Ouachita Seed Orchard has historically had significant losses from this pest (Overgaard 1981). This pest overwinters as a pupa, emerging in early spring prior to pollination. The adults lay eggs on shoots or conelets and hatching larvae often feed on conelets before entering shoots where they complete their development. Often several conelets in a cluster will be lost or the entire tip may die, killing the developing flowers. Tip moths have several generations per year. Apparently at the Ouachita there are 3 distinct generations.

Pest Status - In 1982 the last tip moth generation caused severe mortality of vegetative tips. Apparently Furadan® applied in the spring no longer killed larvae. The 1983 crop was not affected by this tip moth outbreak. However, the flower set in 1983 (1984 crop) was severely reduced. Pheromone traps were installed on March 13, 1983, and the first trap catch was recorded on March 14. Significant numbers of male tip moths were trapped throughout March and April. This protracted flight may have been due to the cool spring. The first aerial application (1983) was timed to coincide with egg hatch of the first generation. Reinfestation of

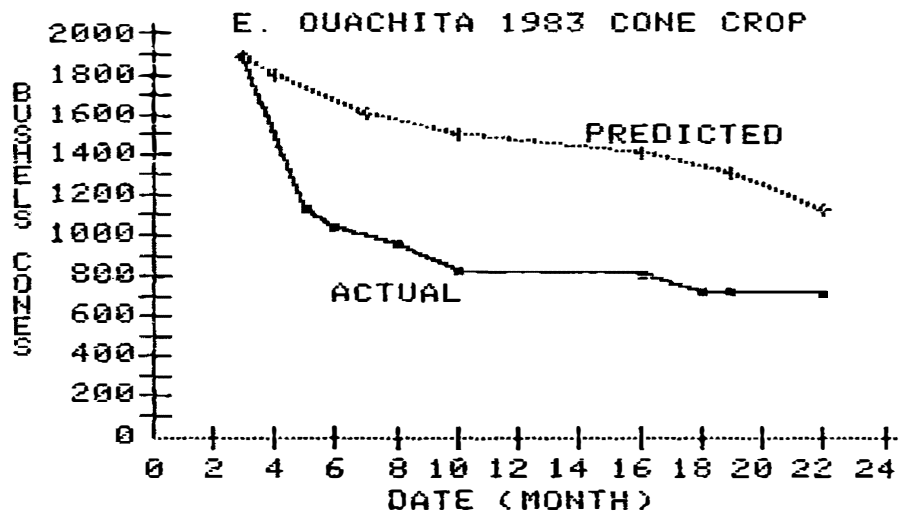


Figure 1A. Survival curve of the 1983 cone crop estimated from the cone and seed inventory monitoring system.

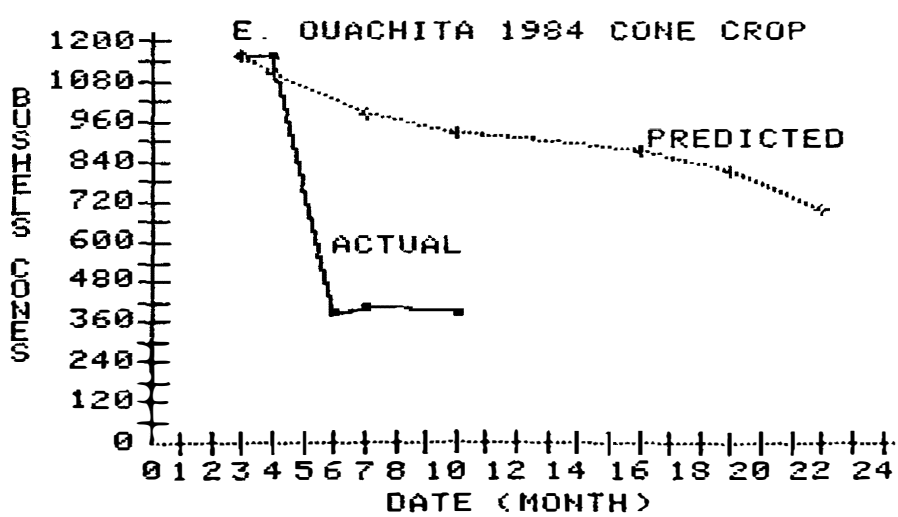


Figure 1B. Survival curve of the 1984 cone crop estimated from the cone and seed inventory-monitoring system.

the East Ouachita seed source by the second tip moth generation occurred by June 7, 1983, when approximately 27% of the vegetative tips showed signs of new infestations. While this infestation level represented a potential problem, conelet losses caused by tip moth between April and June represented only 1.57% (table 5) of the conelets present at the beginning of April. Additional sprays timed for subsequent tip moth generations apparently helped to prevent the buildup of the third generation. Infestation levels remained below the second generation level.

B. Coneworms

Species - *Dioryctria clarioralis* - blister coneworm
D. amatella - southern pine coneworm
D. merkeli - loblolly pine coneworm

Biology - On shortleaf, shoot attacks may be the earliest visible coneworm damage found during the spring. These attacks are usually attributed to *D. merkeli*, the loblolly pine coneworm, which has only 1 generation a year. After overwintering as small larvae, they move from shoots and flowers to cones. The cones die prior to reaching full size. Emergence occurs in the fall (September-November).

Dioryctria clarioralis, the blister coneworm, overwinters as a large larva and does little or no damage prior to pupating in the spring. Blister coneworm adults usually emerge during April and May. Eggs are oviposited soon after emergence and the hatching larvae seem to prefer enlarging cones. Subsequent generations prefer rapidly growing shoots and conelets.

Dioryctria amatella overwinters as an early instar larva and begins feeding on male and female flower buds. Later these larvae migrate to 2nd year cones where they pupate and emerge. Damage from the overwintering generation should occur prior to the first flight which usually begins in April or May The damage on 2nd year cones consists of dead or dying cones with entry holes surrounded but not enclosed by pitch and frass masses. The pheromone traps capture moths in low numbers throughout the season.

Pest Status - Pheromone trapping did not detect the presence of any of the potential coneworm pests. In addition, conelet and cone losses caused by coneworms during the sampling intervals remained below 2%. Therefore, coneworms were not serious threats to either crop during the 1983 growing season. Table 4 lists the pest status and the approximate dates for adult flights of the major *Dioryctria* spp.

C. Seedbugs

Species - *Leptoglossus corculus* (Say) - Leaffooted pine seed bug
Tetyra bipunctata (H.-S.) - Shieldbacked pine seed bug

Biology - The sizes of seedbug populations vary widely among seed orchards. Populations of leaffooted pine seedbugs are considered to be more destructive than populations of shieldbacked pine seedbugs.

Both species overwinter as adults. In the spring, *L. corculus* and *T. bipunctata* adults feed primarily on conelets. Apparently *L. corculus* adults mate and produce a new brood during spring and early summer. This generation is followed by another overlapping brood in July and August. *Tetyra bipunctata* eggs are seldom found prior to mid-July, indicating that the overwintering adults have produced their first brood. This brood matures resulting in the familiar increase in numbers found at harvest.

Pest Status - Very few seedbugs were sighted during the 1983 season. Apparently seedbugs were not serious pests during the 1983 season.

III. Assessment of Impact Caused by Key Pests

The greatest cone and conelet losses occurred between April and June, 1983. During this period, 6.15% of the cones (50 bushels) and 67.56% of the conelets (781 bushels) were damaged, destroyed, or missing. Coneworms were the only identifiable insect pests causing damage to 2nd year cones. Coneworm losses did not exceed 2% of the potential 1983 cone crop.

The projected 1984 crop is considerably smaller than the 1983 crop. This production trend was expected due to the tip moth damage in 1982. However, substantial losses (67.56%) occurred

Table 4. Pest status and approximate dates of major *Dioryctria* spp.

Pest	Status	Dates of Peak Flights
D. merkeli	Unknown	September - November
D. clarioralis	Unknown	May, July, September
D. amatella	Low	Sporadic throughout the summer beginning late April

between April and June, 1983. Most of this damage (65.92%) could not be directly attributed to insect pests. Estimates of preventable losses cannot be determined from the existing data. Based on the inventory-monitoring data from 1982 and 1983, similar numbers of conelets (1,200,000) were lost during a two-month period following pollination in both years. These sizeable losses indicate that additional frequent monitoring may be necessary to identify the causal agent and, if possible, to prevent future losses.

Minimal losses occurred throughout the remainder of the season. Tables 5 and 6 list the mortality agents, numbers of conelets or cones lost, and percentage of the crop which was damaged, destroyed, or missing.

RECOMMENDATIONS

The size of the 1984 cone crop is larger than the 1982 crop but considerably less than the 1983 crop. The size of the 1985 crop can not be determined until early spring. Therefore, it is difficult to determine whether the pest management strategy for FY 84 should feature the 1984 crop, the 1985 crop, or both crops. FPM recommends an intensive spray program in the spring followed by less frequent applications during the summer. The pest management strategy should also be directed at suppressing tip moth population buildup.

Six pest management alternatives are represented in Appendix I. In order to protect the 1984 and 1985 cone crops, FPM recommends a series of pesticide applications applied via aircraft (Appendix I, Alternatives 4 or 6). Alternative 4 consists of 3-6 sprays of either Guthion®, Pydrin®, or Ambush® while Alternative 6 addresses alternating between 2 or more of these insecticides in a spray schedule consisting of 3-6 sprays. Alternative 6 is the preferred alternative. Pydrin, Guthion, and Ambush are registered for aerial applicaton. FPM recommends using Pydrin at a rate of 0.67 lbs of active ingredient per acre for the first spray (aerial application) followed by 3 applications of Guthion applied at a rate of 2 lbs of active ingredient per acre (aerial application).

The Georgia Forest Research Paper #44 (Gargiullo et al. 1983) (see Appendix II) should be consulted when developing the insecticide spray schedule. Pheromone trapping and maximum/minimum temperatures recordings should continue to be utilized. Based upon the duration of the first tip moth flight in 1983, FPM recommends targeting 2 sprays in 1984 for suppression of the first generation tip moth. These applications should be followed by 2 additional applications during the summer. Table 7 summarizes a suggested spray schedule for 1984. Calendar dates should be utilized only for long range planning. Degree day accumulations should be used to refine the spray dates.

Table 5. Summary of cone mortality of the 1983 E. Ouachita shortleaf cone crop.

Mortality Agents	No. of Dead Cones		% Mortality[1/]	
March - April 1983				
Missing	25,311		1.91	
Unknown	16,157		1.22	
Coneworms	13,510		1.02	
Man	1,058		0.08	
TOTAL	56,036		4.22	
April - June 1983				
Missing	27,518		2.12	
Unknown	47,772		3.68	
Coneworms	2,136		0.16	
Coneworm Damage[2/]		466		0.04
Unknown Insect	614		0.05	
Broken Branch	1,854		0.14	
TOTAL	79,894		6.15	
June - August 1983				
Missing	8,433		0.71	
Unknown	8,008		0.68	
Coneworms	3,900		0.33	
Coneworm Damage[2/]		1,261		0.11
Unknown Damage	832		0.07	
TOTAL	21,173		1.79	
August - October 1983				
Missing	1,258		0.11	
Unknown	4,580		0.41	
Coneworms	17,193		1.54	
Coneworm Damage[2/]		3,302		0.30
Unknown Damage	3,242		0.29	
Unknown Insect	626		0.06	
TOTAL	26,899		2.41	

1/ % mortality was calculated based upon the number of cones alive at the beginning of each evaluation interval.

2/ Coneworm damage is included under coneworm heading.

Table 6. Summary of conelet mortality of the the 1984 E. Ouachita shortleaf cone crop.

Mortality Agents	No. of Dead Conelets	% Mortality[1/]
March - April 1983		
Unknown Insects	6,934	0.37
Unknown Insect Damage	963	0.05
TOTAL	7,897	0.42
April - June 1983		
Missing	1,135,700	61.41
Unknown	83,463	4.51
Tip Moth	29,023	1.57
Unknown Insects	958	0.05
Coneworms	379	0.02
TOTAL	1,249,523	67.56
June - August 1983		
Missing	7,473	1.20
Unknown	2,001	0.32
TOTAL	9,474	1.52
August - October 1983		
Missing	17,484	2.73
Unknown	520	0.08
Coneworms	939	0.15
Man	5,640	0.88
TOTAL	24,583	3.84

1/ % mortality was caculated based upon the number of cones alive at the beginning of each evaluation interval.

Table 7. Suggested insecticide spray schedule for 1984.

Application	Accum. °D	Calendar Date[1/]	Chemical
1	375	Early April	Pydrin
2	550	Late April	Guthion
3	626	Late June	Guthion
4	660	August	Guthion

1/ Degree days (°D) accumulated after the date of first moth catch for each generation.

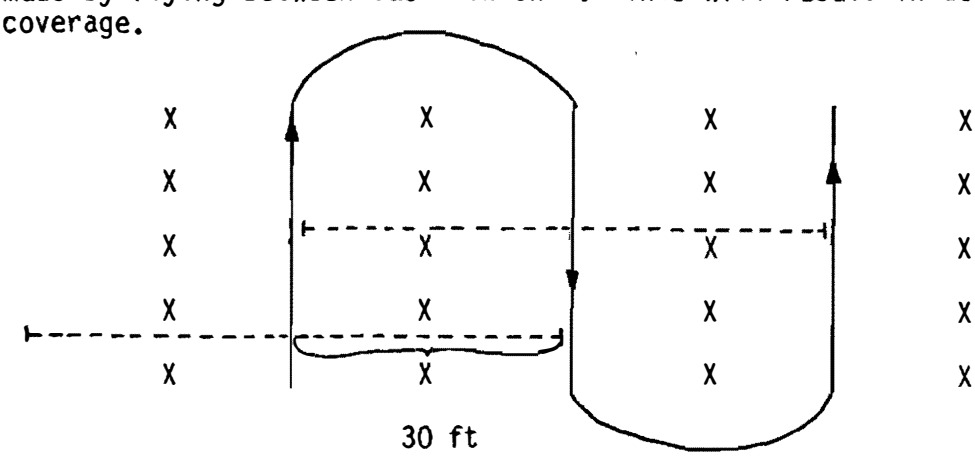
Suggested application specifications for fixed-wing and helicopter are listed below.

Specification	Helicopter	Fixed Wing
Droplet size VMD (Microns)	300-350	300-350
Drop density (drops/cm^2)	30	30
Boom pressure (PSIG)	40	40
Speed (MPH)	25	90
Swath width (ft)	30 or 60	30 or 60
Release height above trees (ft)	5	5
Adjuvant - Nalco-Trol®	3 oz/100 gal H_2O	3 oz/100 gal H_2O

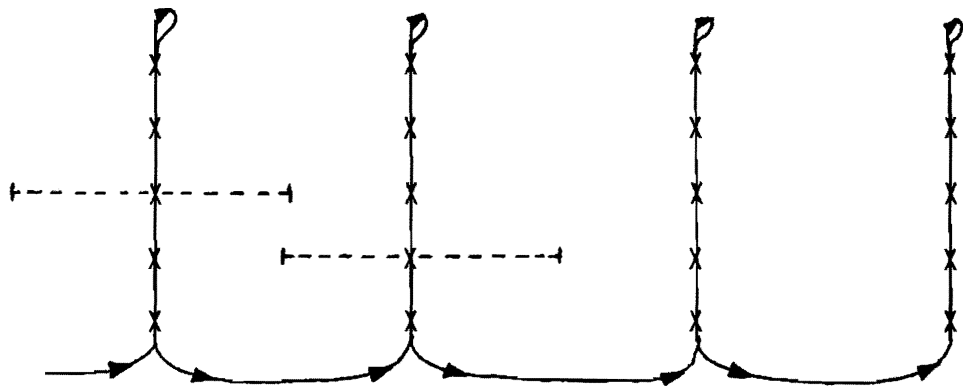
When calibrating the pesticide delivery system, the most important specificaiton is the drop size. For insecticide applications, drops of 300-350 microns are desired. If an applicator can provide adequate and uniform coverage (drop density $\geq$ 30 drops/cm^2) with a volume medium diameter of 300-350 microns, the calibration of the delivery system and the characterization of the spray is acceptable. Guthion 2S can be applied aerially at a maximum rate of 3 lbs of active ingredient per acre in not less than one gallon water per acre. Therefore, 1-pass or 2-pass applications are legal. Pydrin 2.4 EC can be applied aerially at a maximum rate of .75 lbs of active ingredient per acre in not less than 10 gallons of water per acre. Most conventional aircraft can dispense approximately 5 gallons per acre if the drop size (VMD) is kept constant at 300-350 microns. Therefore, under label dilutions Pydrin applications should be 2-pass applications.

If 2-pass applications are necessary the following application patterns are recommended for inclusion in the project control plan and/or the aerial application contract specifications.

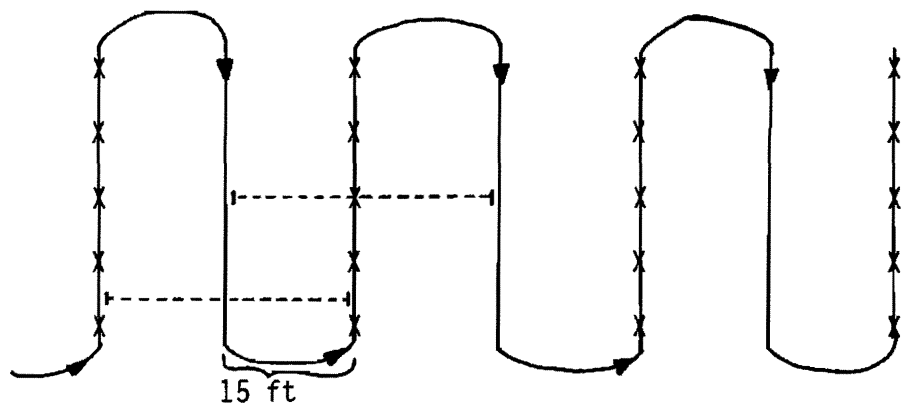
The insecticide will be applied over a 30 or 60 foot swath at a height of 5 feet above the canopy. If the aeiral applicator can provide adequate and uniform coverage (VMD 300-350 micron, drop density of at least 30 drops/cm^2) over a 50-60 foot swath, the application will be made by flying between each row once. This will result in double coverage.



If the applicator can provide adequate and uniform coverage over a swath width of less than 50 feet, the application will be made by flying each row twice



or by flying each space and each row once.



Efforts are being made to change the Pydrin label. This change would allow the aerial application at a maximum rate of .75 lbs of active ingredient in not less than 1 gallon water per acre. FPM recommends trying on an operational basis a 1-pass application of Pydrin during the first application in 1984. This procedure was utilized in 1983 and impact data were compiled indicating suppression of pest populations. In 1984, FPM plans to continue to monitor this 1-pass operational trial and to evaluate effectiveness.

FPM is concerned about the recurring spring losses. Perhaps by monitoring the flower crop more frequently (every 3 days), causes of mortality could be determined. FPM will assist the orchard manager in the development and implementation of a more detailed monitoring program for the spring of 1984.

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APPENDIX I

CONTROL RECOMMENDATIONS

APPENDIX I

SEED ORCHARD PEST MANAGEMENT CONTROL ALTERNATIVES

Alternative 1. No action.

Benefits:

1) Lowers management costs
2) Encourages the natural buildup of beneficial insects and other predators
3) Reduces exposure of personnel to pesticides
4) Discourages the development of resistant strains of pests

Detriments:

1) Losses must be tolerated for indefinite periods of time
2) Pest populations may build to levels which cannot be tolerated before beneficial insects check the increase

Rationale: This alternative is usually selected when the value of the existing crop is less than the cost of the most inexpensive chemical control measure. As second generation orchards begin producing and as superior seed becomes available in storage, 1st generation orchards, or blocks within these orchards, may be placed on low maintenance. Under a low maintenance program, the "No Action" alternative will become an integral component.

Currently this option is of limited value. Young orchards which have not experienced pest population buildups are probably more efficiently managed without a structured spray program. Very few managers of producing orchards consider this a viable alternative.

Alternative 2. One Furadan® application.

Benefits:

1) Targeted at pests which feed on pine, not at beneficial insects
2) One application may reduce pest populations for several months

Detriments:

1) Furadan 15G has a high oral toxicity and must be incorporated into soil
2) High cost for a single application
3) Translocation is dependent upon adequate soil moisture
4) Efficacy decreases by midsummer
5) Application must be made in late winter or early spring when the ground is frozen or wet

Rationale: This alternative is usually considered for fairly well-drained orchards. Many orchards across the Southeast are too wet in late winter, and the application must be delayed. Applications made after mid-February will not effectively control early season pests. Apparently Furadan provides better protection of conelet crops than it does cone crops. If the flower crop is the featured crop, then a single Furadan application may be an effective strategy.

Orchard managers who have chosen this single application strategy must be willing to accept late season losses.

Alternative 3. Split Furadan application.

Benefits:

1) Targeted at pests which feed on pine, not at beneficial insects
2) One application may reduce pest populations for several months
3) Allows for flexibility in determining when Furadan will be effective

Detriments:

1) Furadan 15G has a high oral toxicity and must be incorporated into soil
2) High application and chemical cost
3) Translocation is dependent upon adequate soil moisture
4) Applications may be delayed because of ground conditions

Rationale: This alternative is usually considered in the same orchard where a single Furadan application would be effective. The treatments should be made approximately 6 weeks before the targeted pests are active or before the previous Furadan concentrations have dropped below the lethal concentration (LC). This alternative may allow you to extend the protection associated with Furadan throughout the growing season. In theory, this alternative has potential. However, the inconsistencies associated with Furadan uptake and translocation

probably will make the double application even more inconsistent.

Timing is an important consideration. If the first application is targeted for early season pests, then the standard mid-February application will probably be timely for this first application. Furadan usually dissipates by mid to late summer. Therefore, a second application should be applied in late May or early June.

The 2nd important consideration is the application rate. The current label allows for application of from 2.7 - 5.3 oz. of Furadan 15G for each inch of tree diameter. In a split application, two 2.7 oz. applications should be effective if uptake is sufficient.

Preliminary results indicate that split applications of Furadan used alone do not adequately increase protection over a single application (Overgaard 1976). Additional modifications could be considered but the most important consideration is the benefit:cost of 2 applications as opposed to a single application.

Alternative 4. Three to six sprays of Guthion®, Pydrin®, or Ambush®.

Benefits:

1) Multiple sprays allow flexibility in timing applications
2) Frequency of applications can reflect insect damages and/or population levels
3) Flexibility in method of application (ground, air)

Detriments:

1) Labor intensive
2) Excessive exposure of personnel to restricted use pesticide
3) Ground applications may be delayed by excessive soil moisture
4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative allows more responsiveness to insect population levels and flexibility in targeting an application to coincide with the life cycle of the pests. Guthion, Pydrin and Ambush are the only chemicals currently registered for coneworm and seedbug control which can be applied monthly, throughout the summer, at the recommended rates.

The most widely used formulation of Guthion is the 2S formulation. The 2S formulation does not crystalize when stored

below freezing. In addition, the 2S formulation as compared with the WP formulation can be applied with less wear to spraying equipment. However, the WP formulation has a longer residual than the 2S formulation. It may be advantageous to utilize the advantages of each formulation and use the WP formulation in spring when rainfall is heavy, switching to the less abrasive formulation in the summer and fall.

Pydrin and Ambush are synthetic pyrethroids with low mammalian toxicity. Exposure of orchard personnel to Pydrin or Ambush is much less hazardous than exposure to Guthion. In addition, Pydrin remains at effective concentration for longer periods than Guthion 2S.

The application schedule is extremely important. Applications should be made just prior to the periods when the greatest damages occur. The first spring application usually is made during the week following pollination. This application coincides well with the period when major conelet losses occur and when early coneworm caused losses are beginning. Subsequent sprays are often applied at monthly intervals following the initial spray. If the orchard manager has adequate information to identify and monitor the key pests, then the applications can be targeted for the susceptible stages of the key pests. Currently the technology to monitor and time sprays is limited.

Alternative 5. Furadan combined with supplementary sprays.

Benefits:

1) Insures the orchard is protected during the entire season
2) Increases the suppression efforts against coneworms
3) Early spray applications serve as a backup to Furadan if uptake is minimal

Detriments:

1) Furadan 15G has a high oral toxicity and must be incorporated into soil
2) Translocation is dependent upon adequate soil moisture
3) Application must be made in late winter or early spring when the ground is frozen or wet
4) Labor intensive
5) Ground applications may be delayed by excessive soil moisture
6) Pest management costs are increased substantially
7) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is becoming increasingly popular with industrial orchards. Often the size of the area to be treated is the limiting factor.

If Furadan uptake is sufficient, conelet survival is increased substantially. The highest Furadan concentrations are usually found in the actively growing shoots, making Furadan an ideal pesticide for early season shoot infesting pests such as tip moths. Furadan appears to be less effective against coneworms, damaging 2nd year cones. Therefore, backup sprays increase the suppression efforts targeted for coneworm control. All currently registered pesticides are usually effective against seedbugs.

The major concern when choosing this alternative is timing the supplementary sprays to obtain maximum protection for the increased management costs. If the orchard has a history of early season pests, particularly 1st generation coneworms (*Dioryctria disclusa*, etc.), it may be desirable to apply a pesticide 6 days after peak pollen flight. Beginning in mid-May or early June, 2 to 4 additional sprays should protect 2nd year cones against increasing coneworm populations. If cones are harvested using the traditional hand picking procedures, the last spray would probably be applied 2 or 3 weeks before harvest. If netting is used to harvest seed, the last spray can be delayed to suppress increasing populations of both seedbugs and coneworms.

The choice of insecticides is limited. Currently three insecticides, Pydrin, Guthion, and Ambush, are registered for coneworm and seedbug control. Pydrin and Ambush are ideal chemicals for spray applications during periods when orchard personnel are active within the orchard and during periods when a longer residual is needed. Therefore, spring and fall would be ideal times for Pydrin or Ambush applications while Guthion might be applied in midsummer. This combination of insecticides, Furadan and Guthion, Pydrin or Ambush, should help eliminate many of the sucking insect problems associated with the use of Pydrin and Ambush.

Alternative 6. Three to six sprays of mixed chemicals.

Benefits:

1) Multiple sprays allow flexibility in timing applications
2) Frequency of applications can reflect insect damages and/or population levels
3) Flexibility in method of application (ground, air)
4) Decreased potential for resistant pest populations
5) Less exposure to highly toxic chemicals

Detriments:

1) Labor intensive
2) Excessive exposure of personnel to restricted use pesticide
3) Ground application may be delayed by excessive soil moisture
4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is very similar to Alternative 4. It is usually advantageous to alternate chemicals rather than to depend on one chemical. Alternate applications of chemicals, with different modes of actions, tend to decrease the development of resistant pest populations. Currently, Pydrin, Guthion, and Ambush are the three registered chemicals which fit well into a spray schedule. Hydraulic, mist blower or aerial applications of any of these three chemicals have been demonstrated to effectively suppress coneworm and seedbug populations. The characteristics of each chemical have been described under the rationale section of Alternative 4. These characteristics should help determine when each chemical should be applied.

APPENDIX II

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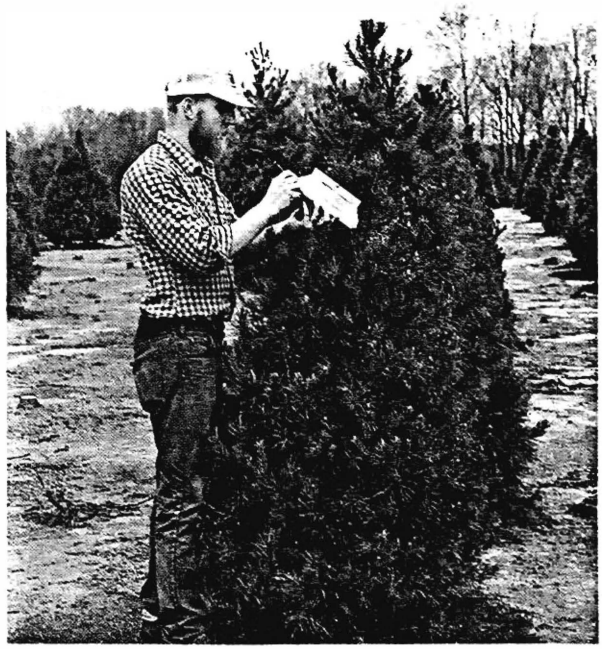

HOW TO TIME DIMETHOATE SPRAYS AGAINST THE NANTUCKET PINE TIP MOTH

BY

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INTRODUCTION

Larvae of the Nantucket pine tip moth feed inside of pine shoots and buds, especially within the upper one-third of the crown. After the destruction of this vigorously growing material, smaller shoots compete with each other for apical dominance, resulting in a bushy or deformed tree. There is also a decrease in tree height growth (Yates, 1960). This may be a problem in loblolly pine plantations managed for pulpwood or sawtimber, but is especially serious on Virginia pines grown for Christmas trees, where cosmetic appearance is important.

Christmas tree growers in the southern piedmont and coastal plain have attempted to control tip moths by spraying Cygon^R (Dimethoate) or Orthene^R (Acephate) every two weeks or every month throughout the growing season. Spraying on such a schedule often produces poor and inconsistent control. Good control can be obtained by using one spray, carefully timed to coincide with the most susceptible stage of each tip moth generation. This occurs during the first and second larval instars. We present here a simple technique by which a grower can predict the optimum spray date using only pheromone traps and daily maximum and minimum temperatures. Research leading to the development of this technique will be reported in Berisford, et al. (1983), and Gargiullo, et al. (unpublished). Cygon^R was used in these studies because it is currently the most popular insecticide used to control tip moths.

PROCEDURE

This technique was developed in the Georgia piedmont, but probably applies to most of the southern piedmont as well, where the Nantucket pine tip moth has three generations per year. An extrapolation of the technique to the coastal plain will be presented below. The technique is performed in two steps.

Step 1: The beginning of each tip moth generation (i.e. adult emergence) must be determined by using pheromone traps (Fig. 1). Information on the availability of the pheromone traps and sex attractant lures can be obtained from the University of Georgia, Department of Entomology, Athens, Georgia[1/]. Eight to 10 traps should be placed at least fifteen feet apart throughout the plantation, on or before the following dates for each generation:

Generation 1	Generation 2	Generation 3
February 21	May 15	July 6

Traps should be examined daily for moth catches (Figs. 2 and 3). When the first moth is found in any one of the traps, go to Step 2.

Step 2: Once the onset of a generation is determined, then degree-days (^{o}D, see Baskerville and Emin, 1969) must be accumulated daily, starting with the day on which the first moth was caught. Degree-days are accumulated day by day until the appropriate sum is reached. When this sum is reached, the following day is the optimum spray date. The required ^{o}D sums for each generation are:

Generation 1	Generation 2	Generation 3
439 ^{o}D	626 ^{o}D	480°D; 840°D

Note that although only one spray is needed for each of generations 1 and 2, two sprays are recommended for generation 3, because the period of activity is longer during that generation.

To find the daily ^{o}D contribution to the accumulating sum, the daily maximum and minimum temperatures are needed. A maximum-minimum thermometer may be obtained from a hardware store, nursery, or local weather reports may be used. Using the ^{o}D tables in the Appendix, find the maximum temperature along the top margin, and the minimum temperature along the left margin. The corresponding table entry is the number of ^{o}D for that day. Consult these tables each day as you accumulate ^{o}D toward the final sum.

Fig. 1 - Two of the common types of insect traps which utilize pheromones or sex attractant lures.

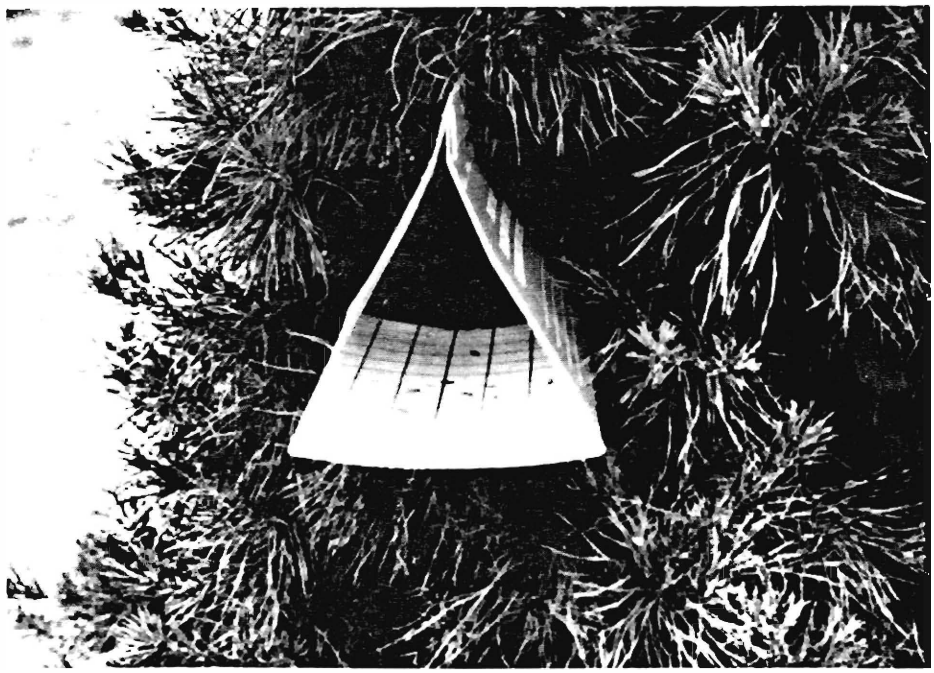

Fig. 2 - Moths are caught on the sticky interior surfaces of the pheromone trap.

1/ Available information on products does not constitute an endorsement by the University of Georgia, The Georgia Forestry Commission nor the U. S. Forest Service.

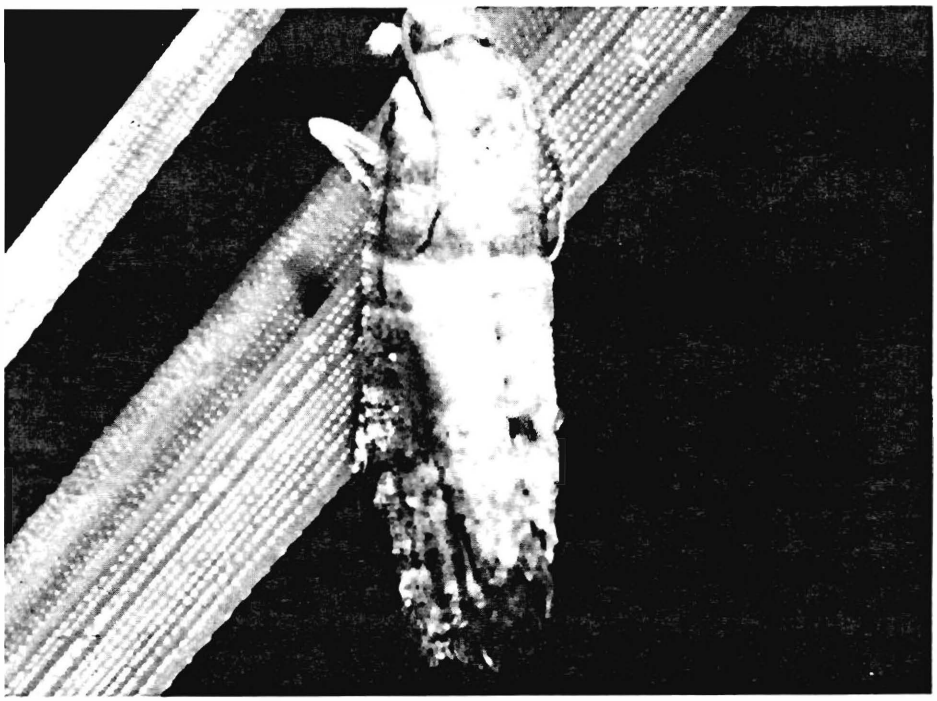

Fig. 3 - Adult Nantucket pine tip moth.

SPECIAL CONSIDERATIONS

1) During their first season in the field, very young pines should be sprayed twice per tip moth generation, according to the following ^{o}D sums:

Generation 1	Generation 2
375°; 550°D	500°; 800°D

Generation 3

480°D; 840°D

Two applications are recommended because the phenology of seedlings is different, requiring different timing, and control on these young trees is critical if quality Christmas trees are to be produced. Tip moth attacks on these young trees can damage tree form considerably

2) The timing technique was developed for the Georgia piedmont areas. However, many Christmas tree plantations are in the coastal plain, where there are four tip moth generations per season. Some success might be obtained by using the following extrapolation of the technique, until more research can be performed specifically for the coastal plain.

Deploy pheromone traps on February 1, May 1, and June 20. Apply insecticide when the appropriate number of degree days are accumulated as for the three generations in the piedmont. After the last timed spray, apply insecticide on a schedule of once every two or three weeks through the middle of October.

DAILY DEGREE-DAYS FOR PREDICTION OF OPTIMUM SPRAY DATE FOR NANTUCKET PINE TIP MOTH

MAXIMUM TEMP *FAHRENHEIT*

MINIMUM TEMP *FAHRENHEIT*	79	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
1-	6	5	5	5	5	4	4	4	3	3	3	3	2	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
2-	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
3-	6	5	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
4-	6	6	5	5	5	4	4	4	4	3	3	3	3	2	2	2	2	1	1	1	1	1	1	0	0	0	0	0	0	0	0
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DAILY DEGREE-DAYS FOR PREDICTION OF OPTIMUM SPRAY DATE FOR NANTUCKET PINE TIP MOTH

MAXIMUM TEMP *FAHRENHEIT*

MINIMUM TEMP FAHRENHEIT	109	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79
1-	14	14	14	13	13	13	13	13	12	12	12	12	11	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7	7	6	6
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9-	15	15	15	14	14	14	14	13	13	13	13	12	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7	6
10-	15	15	15	14	14	14	14	14	13	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7	7
11-	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	12	11	11	10	10	10	9	9	9	9	8	8	8	7	7	7
12-	15	15	15	15	14	14	14	14	14	13	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7
13-	15	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7	7
14-	15	15	15	15	15	14	14	14	14	14	13	13	13	12	12	12	12	11	11	10	10	10	9	9	9	8	8	8	7	7	7
15-	16	15	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7
16-	16	16	15	15	15	15	15	14	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7	7
17-	16	16	15	15	15	15	15	14	14	14	14	13	13	13	13	12	12	12	11	11	10	10	10	9	9	9	8	8	8	7	7
18-	16	16	16	15	15	15	15	15	14	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7
19-	16	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	9	8	8	8	7
20-	16	16	16	16	15	15	15	15	15	14	14	14	14	13	13	13	12	12	12	11	11	10	10	10	9	9	9	8	8	8	7
21-	16	16	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	8	8	8	7
22-	17	16	16	16	16	16	15	15	15	15	14	14	14	14	13	13	13	12	12	11	11	11	10	10	10	9	9	9	8	8	8
23-	17	17	16	16	16	16	15	15	15	15	15	14	14	14	13	13	13	12	12	12	11	11	10	10	10	9	9	9	8	8	8
24-	17	17	16	16	16	16	16	15	15	15	15	14	14	14	13	13	13	12	12	12	11	11	11	10	10	10	9	9	8	8	8
25-	17	17	17	16	16	16	16	16	15	15	15	15	14	14	14	13	13	13	12	12	11	11	11	10	10	10	9	9	9	8	8
26-	17	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	13	12	12	12	11	11	11	10	10	9	9	9	8	8
27-	17	17	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	12	12	12	11	11	11	10	10	10	9	9	8	8
28-	18	17	17	17	17	16	16	16	16	16	15	15	15	14	14	14	13	13	13	12	12	12	11	11	10	10	10	9	9	9	8
29-	18	17	17	17	17	17	16	16	16	16	15	15	15	15	14	14	14	13	13	12	12	12	11	11	11	10	10	9	9	9	8
30-	18	18	17	17	17	17	17	16	16	16	16	15	15	15	14	14	14	13	13	13	12	12	11	11	11	10	10	10	9	9	9
31-	18	18	18	17	17	17	17	17	16	16	16	16	15	15	15	14	14	14	13	13	12	12	12	11	11	10	10	10	9	9	9
32-	18	18	18	18	17	17	17	17	17	16	16	16	15	15	15	14	14	14	13	13	13	12	12	11	11	11	10	10	10	9	9
33-	18	18	18	18	18	17	17	17	17	16	16	16	16	15	15	15	14	14	13	13	13	12	12	12	11	11	10	10	10	9	9
34-	19	18	18	18	18	18	17	17	17	17	16	16	16	16	15	15	14	14	14	13	13	13	12	12	11	11	11	10	10	9	9
35-	19	19	18	18	18	18	18	17	17	17	17	16	16	16	15	15	15	14	14	13	13	13	12	12	12	11	11	10	10	10	9
36-	19	19	19	18	18	18	18	18	17	17	17	17	16	16	16	15	15	14	14	14	13	13	13	12	12	11	11	11	10	10	9
37-	19	19	19	19	18	18	18	18	18	17	17	17	16	16	16	15	15	15	14	14	14	13	13	12	12	12	11	11	10	10	10
38-	20	19	19	19	19	18	18	18	18	18	17	17	17	16	16	16	15	15	15	14	14	13	13	13	12	12	11	11	11	10	10
39-	20	20	19	19	19	19	19	18	18	18	18	17	17	17	16	16	16	15	15	14	14	14	13	13	12	12	12	11	11	10	10
40-	20	20	20	19	19	19	19	19	18	18	18	17	17	17	17	16	16	15	15	15	14	14	13	13	13	12	12	11	11	11	10
41-	20	20	20	20	19	19	19	19	19	18	18	18	17	17	17	16	16	16	15	15	14	14	14	13	13	12	12	12	11	11	10
42-	21	20	20	20	20	20	19	19	19	19	18	18	18	17	17	17	16	16	15	15	14	14	13	13	13	13	12	12	11	11	11
43-	21	21	20	20	20	20	20	19	19	19	19	18	18	18	17	17	17	16	16	15	15	15	14	14	13	13	13	12	12	11	11
44-	21	21	21	20	20	20	20	20	19	19	19	19	18	18	18	17	17	16	16	16	15	15	14	14	14	13	13	12	12	12	11
45-	21	21	21	21	21	20	20	20	20	19	19	19	19	18	18	18	17	17	16	16	16	15	15	14	14	14	13	13	12	12	11
46-	22	22	21	21	21	21	20	20	20	20	20	19	19	19	18	18	18	17	17	16	16	15	15	15	14	14	13	13	13	12	12
47-	22	22	22	21	21	21	21	21	20	20	20	20	19	19	19	18	18	17	17	17	16	16	15	15	15	14	14	13	13	13	12
48-	22	22	22	22	22	21	21	21	21	21	20	20	20	19	19	19	18	18	17	17	17	16	16	15	15	15	14	14	13	13	12
49-	23	23	22	22	22	22	22	21	21	21	21	20	20	20	19	19	19	18	18	17	17	17	16	16	15	15	15	14	14	13	13
50-	23	23	23	23	23	22	22	22	22	22	21	21	21	20	20	20	19	19	18	18	18	17	17	16	16	16	15	15	14	14	13
51-	24	24	24	23	23	23	23	23	22	22	22	22	21	21	21	20	20	19	19	19	18	18	17	17	17	16	16	15	15	14	14
52-	24	24	24	24	24	24	23	23	23	23	22	22	22	22	21	21	20	20	20	19	19	18	18	18	17	17	16	16	15	15	15

DAILY DEGREE-DAYS FOR PREDICTION OF OPTIMUM SPRAY DATE FOR NANTUCKET PINE TIP MOTH

MAXIMUM TEMP *FAHRENHEIT*

MINIMUM	78	77	76	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
53-	15	14	14	14	13	13	12	12	11	11	11	10	10	9	9	9	8	8	7	7	6	6	6	5	5	4					
54-	15	15	15	14	14	13	13	12	12	12	11	11	10	10	10	9	9	8	8	7	7	7	6	6	5						
55-	16	16	15	15	14	14	13	13	13	12	12	11	11	11	10	10	9	9	8	8	8	7	7	6							
56-	17	16	16	15	15	14	14	14	13	13	12	12	12	11	11	10	10	9	9	9	8	8	7								
57-	17	17	16	16	15	15	15	14	14	13	13	13	12	12	11	11	10	10	10	9	9	8									
58-	18	17	17	16	16	16	15	15	14	14	14	13	13	12	12	11	11	11	10	10	9										
59-	18	18	17	17	17	16	16	15	15	15	14	14	13	13	12	12	12	11	11	10											
60-	19	18	18	18	17	17	16	16	16	15	15	14	14	13	13	13	12	12	11												
61-	19	19	19	18	18	17	17	17	16	16	15	15	14	14	14	13	13	12													
62-	20	20	19	19	18	18	18	17	17	16	16	15	15	15	14	14	13														
63-	21	20	20	19	19	19	18	18	17	17	16	16	16	15	15	14															
64-	21	21	20	20	20	19	19	18	18	17	17	17	16	16	15																
65-	22	21	21	21	20	20	19	19	18	18	18	17	17	16																	
66-	22	22	22	21	21	20	20	19	19	19	18	18	17																		
67-	23	23	22	22	21	21	20	20	20	19	19	18																			
68-	24	23	23	22	22	21	21	21	20	20	19																				
69-	24	24	23	23	22	22	22	21	21	20																					
70-	25	24	24	23	23	23	22	22	21																						
71-	25	25	24	24	24	23	23	22																							
72-	26	25	25	25	24	24	23																								
73-	26	26	26	25	25	24																									
74-	27	27	26	26	25																										
75-	28	27	27	26																											
76-	28	28	27																												
77-	29	28																													
78-	29																														
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103-																															
104-																															

DAILY DEGREE-DAYS FOR PREDICTION OF OPTIMUM SPRAY DATE FOR NANTUCKET PINE TIP MOTH

MAXIMUM TEMP *FAHRENHEIT*

MINIMUM TEMP *FAHRENHEIT*	109	108	107	106	105	104	103	102	101	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	80	79
53-	25	25	25	24	24	24	24	24	23	23	23	23	22	22	22	21	21	21	20	20	19	19	19	18	18	17	17	16	16	16	15
54-	26	25	25	25	25	25	24	24	24	24	24	23	23	23	22	22	22	21	21	20	20	20	19	19	18	18	17	17	17	16	16
55-	26	26	26	26	25	25	25	25	25	24	24	24	24	23	23	23	22	22	21	21	21	20	20	19	19	18	18	18	17	17	16
56-	27	26	26	26	26	26	26	25	25	25	25	24	24	24	24	23	23	22	22	22	21	21	20	20	19	19	19	18	18	17	17
57-	27	27	27	27	26	26	26	26	26	25	25	25	25	24	24	24	23	23	23	22	22	21	21	20	20	20	19	19	18	18	18
58-	28	28	27	27	27	27	27	26	26	26	26	26	25	25	25	24	24	24	23	23	22	22	21	21	21	20	20	19	19	19	18
59-	28	28	28	28	28	27	27	27	27	27	26	26	26	26	25	25	25	24	24	23	23	22	22	22	21	21	20	20	20	19	19
60-	29	29	28	28	28	28	28	28	27	27	27	27	26	26	26	26	25	25	24	24	23	23	23	22	22	21	21	21	20	20	19
61-	29	29	29	29	29	28	28	28	28	28	27	27	27	27	26	26	26	25	25	24	24	24	23	23	22	22	22	21	21	20	20
62-	30	30	30	29	29	29	29	29	28	28	28	28	28	27	27	27	26	26	25	25	25	24	24	23	23	23	22	22	21	21	20
63-	30	30	30	30	30	30	29	29	29	29	29	28	28	28	28	27	27	26	26	26	25	25	24	24	24	23	23	22	22	21	21
64-	31	31	31	30	30	30	30	30	30	29	29	29	29	28	28	28	27	27	27	26	26	25	25	25	24	24	23	23	22	22	22
65-	31	31	31	31	31	31	30	30	30	30	30	30	29	29	29	28	28	28	27	27	26	26	26	25	25	24	24	23	23	23	22
66-	32	32	32	32	31	31	31	31	31	30	30	30	30	30	29	29	29	28	28	27	27	27	26	26	25	25	24	24	24	23	23
67-	32	32	32	32	32	32	32	31	31	31	31	31	30	30	30	30	29	29	28	28	28	27	27	26	26	25	25	25	24	24	23
68-	33	33	33	33	32	32	32	32	32	32	31	31	31	31	30	30	30	29	29	29	28	28	27	27	26	26	26	25	25	24	24
69-	33	33	33	33	33	33	33	32	32	32	32	32	32	31	31	31	30	30	30	29	29	28	28	27	27	27	26	26	25	25	25
70-	34	34	34	34	33	33	33	33	33	33	33	32	32	32	32	31	31	31	30	30	29	29	28	28	28	27	27	26	26	26	25
71-	34	34	34	34	34	34	34	34	33	33	33	33	33	32	32	32	32	31	31	30	30	29	29	29	28	28	27	27	27	26	26
72-	35	35	35	35	35	34	34	34	34	34	34	33	33	33	33	32	32	32	31	31	30	30	30	29	29	28	28	28	27	27	26
73-	35	35	35	35	35	35	35	35	34	34	34	34	34	34	33	33	33	32	32	31	31	31	30	30	29	29	29	28	28	27	27
74-	36	36	36	36	36	35	35	35	35	35	35	35	34	34	34	34	33	33	32	32	32	31	31	30	30	30	29	29	28	28	27
75-	36	36	36	36	36	36	36	36	36	35	35	35	35	35	34	34	34	33	33	33	32	32	31	31	31	30	30	29	29	28	28
76-	37	37	37	37	37	36	36	36	36	36	36	36	35	35	35	35	34	34	34	33	33	32	32	32	31	31	30	30	29	29	29
77-	37	37	37	37	37	37	37	37	37	36	36	36	36	36	36	35	35	35	34	34	33	33	33	32	32	31	31	30	30	30	29
78-	38	38	38	38	38	37	37	37	37	37	37	37	37	36	36	36	36	35	35	34	34	34	33	33	32	32	31	31	31	30	30
79-	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	36	36	36	35	35	35	34	34	33	33	32	32	32	31	31	30
80-	39	39	39	39	39	38	38	38	38	38	38	38	38	37	37	37	37	36	36	36	35	35	34	34	33	33	33	32	32	31	
81-	39	39	39	39	39	39	39	39	39	39	38	38	38	38	38	38	37	37	37	36	36	35	35	34	34	34	33	33	32		
82-	40	40	40	40	39	39	39	39	39	39	39	39	39	39	38	38	38	38	37	37	36	36	35	35	35	34	34	33			
83-	40	40	40	40	40	40	40	40	40	40	39	39	39	39	39	39	38	38	38	37	37	36	36	36	35	35	34				
84-	41	41	40	40	40	40	40	40	40	40	40	40	40	40	39	39	39	39	38	38	37	37	37	36	36	35					
85-	41	41	41	41	41	41	41	41	41	41	40	40	40	40	40	40	40	39	39	38	38	38	37	37	36						
86-	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	40	40	40	39	39	39	38	38	37							
87-	42	42	42	42	42	42	42	42	41	41	41	41	41	41	41	41	41	40	40	40	39	39	38								
88-	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	41	41	40	40	39									
89-	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41	41	40										
90-	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	42	42	42	42	41											
91-	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	42												
92-	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43													
93-	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43														
94-	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43															
95-	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43																
96-	43	43	43	43	43	43	43	43	43	43	43	43	43	43																	
97-	43	43	43	43	43	43	43	43	43	43	43	43	43																		
98-	43	43	43	43	43	43	43	43	43	43	43	43																			
99-	43	43	43	43	43	43	43	43	43	43	43																				
100-	43	43	43	43	43	43	43	43	43	43																					
101-	43	43	43	43	43	43	43	43	43																						
102-	43	43	43	43	43	43	43	43																							
103-	43	43	43	43	43	43	43																								
104-	43	43	43	43	43	43																									

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Baskerville, G. L., and P. Emin. 1969. Rapid estimation of heat accumulation from maximum and minimum temperatures. Ecology 50(3): 514-517.

Berisford, C. W., Gargiullo, P. M., and C. G. Canalos. 1983. Optimum times for chemical control of the Nantucket pine tip moth, Rhyacionia frustrana (Comstock). (In review).

Yates, H. O. III. 1960. The Nantucket pine tip moth - a literature review. U. S. For. Serv., Southeastern For. Exp. Sta., Asheville, N.C. Sta. Paper No. 115, 19 pp.

PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in their original containers under lock and key out of reach of children and animals, and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear appropriate protective clothing.

If your hands become contaminated with a pesticide, wash them immediately with soap and water. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove the clothing immediately and wash skin thoroughly. After handling or spraying pesticides, do not eat or drink until you have washed with soap and water.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your county agent, state extension specialist or FPM to be sure it is still registered for the intended use. For further information or assistance, contact Forest Pest Management, Alexandria Field Office, Pineville, La., 71360, (Telephone: FTS 497-7280, or Commercial 318/473-7280).

REPORT NO. 84-2-8 3430
ALEXANDRIA FIELD OFFICE JANUARY 1984

BIOLOGICAL EVALUATION OF INSECT DAMAGE AT THE OUACHITA SEED ORCHARD, OUACHITA NATIONAL FOREST (1983)

Prepared by: Julie C. Weatherby
Entomologist

Huey Wallace
Biological Technician

Robert W. Goar / JCW
Biological Aid

Approved by: David B. Drummond
for HARVEY V. TOKO
Staff Director
Forest Pest Management

SOUTHERN REGION, STATE AND PRIVATE FORESTRY
USDA, FOREST SERVICE, ATLANTA, GA 30367